# NREL's Solar Energy Research Facility

*...converting sunlight into electricity*

NREL's Solar Energy Research Facility (SERF) is a state-of-the-art research facility used to develop technologies for converting sunlight into electricity. Completed in October 1993, SERF houses 42 laboratories where research into photovoltaics (PV), superconductivity and related material sciences is conducted.

The $19.6 million, 115,000 square-foot facility is made up of three adjoining modules. Each module has two pods, a laboratory pod in the back, and an office pod in the front. SERF accommodates approximately 170 employees. The facility incorporates numerous energy saving features that make it one of the government's most energy-efficient buildings.

## SERF's Energy-Efficient Features

**Daylighting—**office areas and adjoining corridors are lit by sunlight, greatly reducing the need for artificial lighting. Since artificial lighting generates considerable amounts of heat, cooling costs are reduced. Highly reflective interior surfaces enhance daylighting.

**Energy-Efficient Lighting—**standard office fluorescent lights operate at 72 watts. SERF's high-efficiency lights use only 52 watts of power and provide similar lighting levels.

**Window Shades Controlled by Photovoltaic Sensor—**glare and solar heat gain are managed by sensor-controlled, motorized shades that automatically raise and lower based on the sun's intensity.

**Direct Evaporative Cooling—**uses evaporation to lower air temperature and increase humidity, and then distributes air throughout the building. Direct evaporative cooling uses less energy than conventional air conditioning.

**Indirect Evaporative Cooling—**an intermediary heat exchanger is used to cool air streams without using water vapor. It can also be used to cool a closed-loop system, such as is used to cool the building and equipment.

**Laboratory Exhaust Heat Recovery—**a heat exchanger recovers heat generated by equipment and lights and uses it to preheat fresh, incoming air, displacing 50% to 60% of the energy that would otherwise be required to heat incoming air.

**High-Efficiency Motors—**use 2% to 3% less electricity than standard motors to produce the same mechanical output.

**Variable Frequency Drives—**fan rotors used for ventilation are operated at the speed and power needed to meet demand, unlike conventional systems that operate at maximum power.

**Upsized Cooling Tower—**oversized to provide more contact area between water to be cooled and the circulating air stream. Air-flow pressure drop is reduced, and less fan horsepower is required to provide the same cooling tower performance.

**Selective Glazing—**used in certain areas of the building to reduce direct solar heat gain.

## *Energy Conservation*

SERF was designed and constructed to meet or exceed all applicable environmental, safety and health codes and standards. SERF's annual energy costs are expected to be 30% to 40% lower than a similar building designed to meet federal standards.

SERF cost $170 per square foot to design and construct, less than half the cost of a typical research facility. The facility demonstrates that an innovative research laboratory can be both cost effective and energy efficient.

## *Laboratories*

SERF provides scientists with laboratory space that was specifically designed to support internationally recognized photovoltaic and related technology development. The laboratories are composed of two parallel rows of bays separated by a 14-foot-wide service corridor.

## *Materials Research*

Laboratories on the first floor of SERF's west module are used to develop semiconductor material for high-efficiency crystalline solar cells. Researchers from these labs have made a 29.5% efficient Gallium-Indium Phosphide/Gallium Arsenide solar cell, a world record for solar cell efficiency. Efficiency is the amount of sunlight a solar cell converts into electricity.

Materials for thin film solar cells and superconductors are fabricated in labs on the second floor. Thin film solar cells are about 50 times thinner than crystalline solar cells and are easier to make. With an efficiency of 17.8%, NREL's Copper Indium Gallium Diselenide solar cell holds the world record for a thin film device.

## *Device Fabrication*

Prototype solar cells are fabricated in laboratories in the center module. These labs include a device development laboratory and a clean room where air and light are filtered to minimize impurities in the solar cells. The center module also includes laboratories to analyze the semiconductor material used to make solar cells, and for research into hydrogen generation and storage.

## *Measuring Performance*

Labs in the east module are used to measure and characterize the performance of solar cells and modules made by NREL researchers, industry partners and universities. NREL conducts more than 17,000 measurements each year. Researchers analyze materials, characterize device performance, evaluate fabrication problems and model solar cell and module performance with computers.

## *PV Systems*

On top of SERF's east and west office pods, 10 photovoltaic panels have been installed to study the performance of integrated PV systems on commercial buildings. The panels generate as much as 12 kilowatts of electricity that is fed into the Public Service Company of Colorado's power grid.